Carbon-based solid acid prepared from rice husk char for biodiesel production by catalytic esterification in a continuous esterification apparatus with a rectifying column

D. M. Tong[*], *F. R. Huang*

College of Chemistry, Sichuan University, Chengdu 610064, Sichuan, P. R. China.

1. Introduction –The use of biodiesel, an alternative of diesel fuel, can reduce the dependency upon petroleum-based energy resources, and alleviate the environmental pressure resulted from the use of fossil fuel, then satisfy the requirement of sustainable development. The synthesis of biodiesel from low-cost feedstocks with high acid value such as waste cooking oil and inedible oils is the research focus for reducing cost. Heterogeneous solid acid catalysts can catalyse esterification and transesterification simultaneously, and are used widely to synthesize biodiesel from the lipids with high acid value.

2. Experimental - A series of carbon-based solid acid catalysts were prepared from rice husk char and applied in the esterification of lauric acid and methanol, which is used as a probe reaction of biodiesel preparation from the lipids with high acid value. XRD, FTIR, BET, NH_3-TPD and elemental analysis were used to characterize the catalysts and investigate the influence of preparation parameters and reaction conditions on the catalytic activity.

Table 1 The BET properties, elemental analysis and surface acidity of carbon-based solid acids.

Catalyst	Surface area	Elemental composition /%			Acid density
	($m^2 \cdot g^{-1}$)	C	H	S	(mmol/g)
Rice husk char	-	42.73	2.84	< 1.0	-
SH-1h	94.3	40.71	2.78	1.53	2.138
SH-2h	112.8	40.53	2.59	1.47	3.321
SH-4h	139.8	37.42	2.64	1.70	5.398
SH-8h	160.0	41.90	2.61	1.85	4.465

3. Results and Discussion – The characteristic results of carbon-based solid acids are shown in **Table 1**. The stability of carbon-based solid acid is depicted in **Image 1**.

4. Conclusions - The $–SO_3H$ groups bonded with amorphous carbon consisting of polycyclic aromatic carbon sheets supplied the predominant surface acid sites on the catalysts. SH-4h carbon-based solid acid, prepared by the sulfonation in concentrated H_2SO_4 as sulfonating agent for 4 h, had the highest surface acid density and then exhibited the best catalytic activity for the esterification. The yield of methyl laurate reached 99.7 % when the esterification was carried out in a continuous esterification apparatus with a rectifying column for 4 h. SH-4h catalyst also exhibited good stability.

5. References

[1] K. H. Jiang, D. M. Tong, J. Q. Tang, R. L. Song, C. W. Hu, *Appl. Catal. A*, **389**(1-2), (2010)p. 46.
[2] M. Toda, A. Takagaki, M. Okamura, J. N. Kondo, S. Hayashi, K. Domen, M. Hara, *Nature*, **438**(7065), (2005)p. 178.